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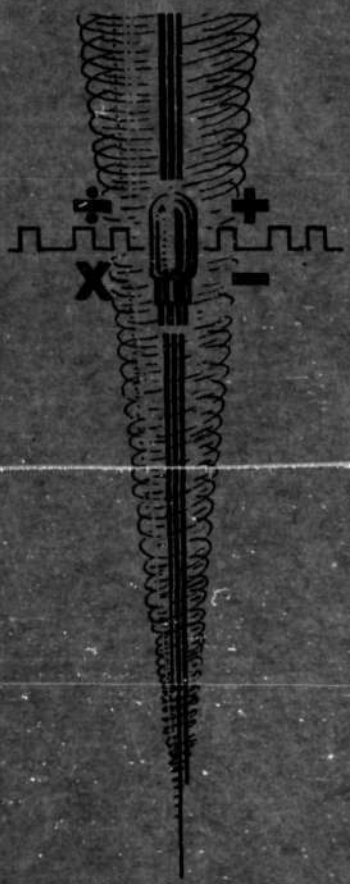
Dr. E. R. Piore

PROJECT WHIRLWIND

Contract N5ori60
Project NR-720-003



L-12

SUGGESTED TOPICS FOR ONR CONFERENCE

APRIL 7 and 8, 1949

SERVOMECHANISMS LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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FOREWORD

This memorandum is an outline of Project Whirlwind computer activity which has been prepared to assist in a conference and discussion of the project with ONR.

The outline omits many details, but covers major headings of the project, and we hope it will assist in selecting topics for consideration.

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APPENDIX

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I. COMPUTER APPLICATIONS (Forrester)

A. Computers for Information Processing - Logistics, fire control, air traffic, scientific computation.

B. Simulation.

1. Initial project goal - aircraft simulator.

2. Naval War College applications - L-1 submarine task group.

3. Aircraft crew training, GCA crew training.

C. Tactical Operation.

1. Tracking while scanning.

2. Mk. 65 program.

3. Guided missile control.

4. Interception.

5. Report L-2 - Task Force system of interconnected digital computers.

D. Scientific computing center.

1. Routine computing - High-speed traffic network.

a. Center of Analysis.

b. Franklin Institute.

2. New mathematical research with computers.

E. Report L-3 on Military Future of Computers.

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II. GENERAL COMPUTER PHILOSOPHY OF PROJECT WHIRLWIND (Forrester, Everett)

A. Project Objective: Suitable high-speed electronic digital computer equipment to permit studies of this form of information processing to the types of applications in Part I. The equipment development and improvement phase would continue in the future but would be as a supporting activity to applications research.

B. Reliable, operating equipment most important.

1. Best engineering is none too good to achieve reliability several orders of magnitude better than other known equipment.

2. Substantial effort devoted to automatic checking and trouble location.

3. Systems engineering, testing of circuits before assembly in computer, test equipment, life tests.

C. General purpose digital computer simpler than special purpose computers. Flexibility leads to lower total development cost by concentrating on one rather than many types of equipment.

D. Speed-Storage Diagram (Curve enclosed).

1. Capacity of computer determined by these two quantities.

2. Area for control and simulation dictated by efficiency.

E. Cost/million operations versus speed.

1. Higher speeds, because amount of equipment is not proportionately increased, leads to higher efficiency.

F. Need to build machine to accelerate math and application work which will not be undertaken until it exists.

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II.a WHIRLWIND I COMPUTER DESCRIPTION (Everett, Salzer)

A. Description of Whirlwind I Computer.

1. Block Diagrams:

a. Parallel throughout.
b. Flexible control.
c. Electrostatic storage.
d. Eastman film units for initial input-output.

2. Block Diagram Report.

3. Work approximately equally divided between storage, arithmetic and control.

B. Flexibility of design in a research tool.

1. Control orders and matrix.

2. Power and video wiring.

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III. ARITHMETIC ELEMENT (Taylor, Sumner, Hoberg)

A. Description.

B. Photos and Dates Tracing Development Stages.

1. Component breadboards.

2. Accumulator breadboard.

3. Five-Digit arithmetic element.

4. Final prototype.

5. Final arithmetic element digits.

6. Combination into final system.

C. Inspection and demonstration.

1. Complete and operating.

2. 50,000 multiplications per second (test speed of arithmetic element, not final computer speed which is less).

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IV. CENTRAL CONTROL (O'Brien, Taylor, Gould)

A. Initial work on crystal matrix switches.

1. D. R. Brown thesis.

2. 32-position switch.

B. Block Diagrams established November 1947.

1. Computer operations may easily be changed at any time.

C. Design studies.

1. Breadboards of all important elements.

2. Matrix investigations.

3. Breadboard studies of driving problems.

D. List of elements.

1. Pulse generator.

2. Synchronizer and restorer pulse generator.

3. Clock pulse control.

4. Time pulse distributor.

5. Operation switch.

6. Control matrices.

7. Control pulse outputs.

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V. STORAGE (Youtz, Klemperer, Dodd)

A. Storage Tube Description:

1. Tube Operation.

2. Comparison with other tubes.

3. Glass and Vacuum Laboratory.

4. TV test equipment.

B. Deflection Circuits description (Ely).

C. Readout circuit description (Nolan).

D. Demonstration of Basement Equipment (Ely, Sisson, Hoberg).

E. Electrostatic Storage Control.

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VI. INPUT-OUTPUT (Everett, Boyd, Rich)

A. General Discussion.

1. Dependent on Computer Application.

a. Display devices and physical inputs needed for simulation.

b. Analog to digital data conversion for control.

c. Printed and graphical for scientific work.

2. Only minimum in-out to be provided at first in form of Eastman equipment with teletype link.

3. Erasable medium will eventually be required.

4. Any active, full-scale use of computers will probably require more terminal facilities.

B. Description of Eastman Kodak units.

C. In-Out Control.

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VII. CHECKING AND TROUBLE LOCATION (Forrester)

A. General Discussion.

1. Permanent versus intermittent faults.

2. Relay random versus tube gradual failures.

B. Marginal Checking (Rich, Read)

1. General principles.

2. Application and test results on five-digit multiplier.

3. Five-Digit multiplier inspection.

4. Whirlwind I demonstration.

C. Trouble Location Problems (Sumner, Adams)

1. Logical nature of problems.

a. Test system function, not individual components.

2. Hoberg-Blumenthal thesis.

3. Sumner thesis.

4. Current work on trouble location.

D. Check problems.

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VIII. SYSTEMS ENGINEERING (Forrester, Fahnestock, Taylor)

A. Meaning:

1. Integration of components to work together.

2. Individual tests to insure working in system.

3.

B. Timing Studies (Hoberg).

1. Laboratory.

2. Theoretical.

3. Experimental verification.

C. Test Equipment (Kenosian).

1. Necessity for special equipment for computer work.

2. Types and uses.

3. Laboratory inspection and demonstration.

D. Power Supplies (Wieser)

1. Need to isolate from line.

2. Type of filtering and control.

3. Inspection.

E. Life and Reliability Tests (Taylor, Frost).

1. Vacuum tube life tests.

a. M.I.T.

b. Sylvania.

2. Vacuum tube records.

a. Complete records kept on all tubes.

3. Five-Digit multiplier history.

4. Storage Tube tests (Corderman)

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VIII. SYSTEM ENGINEERING (continued)

F. Basic Circuits (O'Brien)

1. Objectives.

a. Computer made up of a few basic elements used in many combinations.

2. Description.

3. Detailed reports.

4. Discussion of how a panel is laid out.

G. Computer wiring and cabling (Watt).

1. Marginal checking.

2. Fusing.

3. Accessibility.

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IX. MATHEMATICS (Franklin, Welchman)

A. Present work limited to trouble-location checking and demonstration problems.

B. Applications studies now assigned to other projects.

C. Mathematical work started with investigation of problems presented by the aircraft analyzer and developed into a general study of numerical analysis with the object of discovering the most suitable methods for use on a Whirlwind type computer. This work has provided valuable information on which to base computer capacities and the design of control orders. The following fields were investigated and in some cases detailed codes were prepared.

1. Simultaneous linear equations.
2. Ordinary differential equations.
3. Empirical functions.
4. Integral equations.
5. Partial differential equations.

D. Applications studies have been or are being made in the following fields:

1. Ship stability thesis.
2. Aircraft analyzer.
3. Ballistics.
4. Sorting problems.
5. Non-linear servomechanisms thesis.
6. A-c network analysis thesis.

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X. ACTIVITIES WHICH HAVE BEEN DISCONTINUED (temporarily or permanently)

A. Aircraft Analyzer (Forrester)

1. Equations.

2. Cockpit.

3. Control Force Loading.

B. Data Conversion (Wieser).

C. Magnetic Recording (Rich).

D. General Mathematical Research.

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XI. PROJECT MANAGEMENT (Forrester, Boyd, Fahnestock, Nelson).

A. Nature of laboratory organization.

1. Length of time with M.I.T. versus project position.

B. Time Schedules for planning.

1. Future work.

C. Reports.

D. Visitors.

E. Budgets and cost allocations.

F. Changes in personnel on ONR work.

1. Air traffic research.

G. Production and production control.

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XII FUTURE PROJECT PLANS (Forrester)

A. Computer Maintenance.

B. Operating Group.

C. Scientific Computing.

D. Naval CIC and Fire Control.

E. Logistics.

F. Improvements and extension of Whirlwind I.

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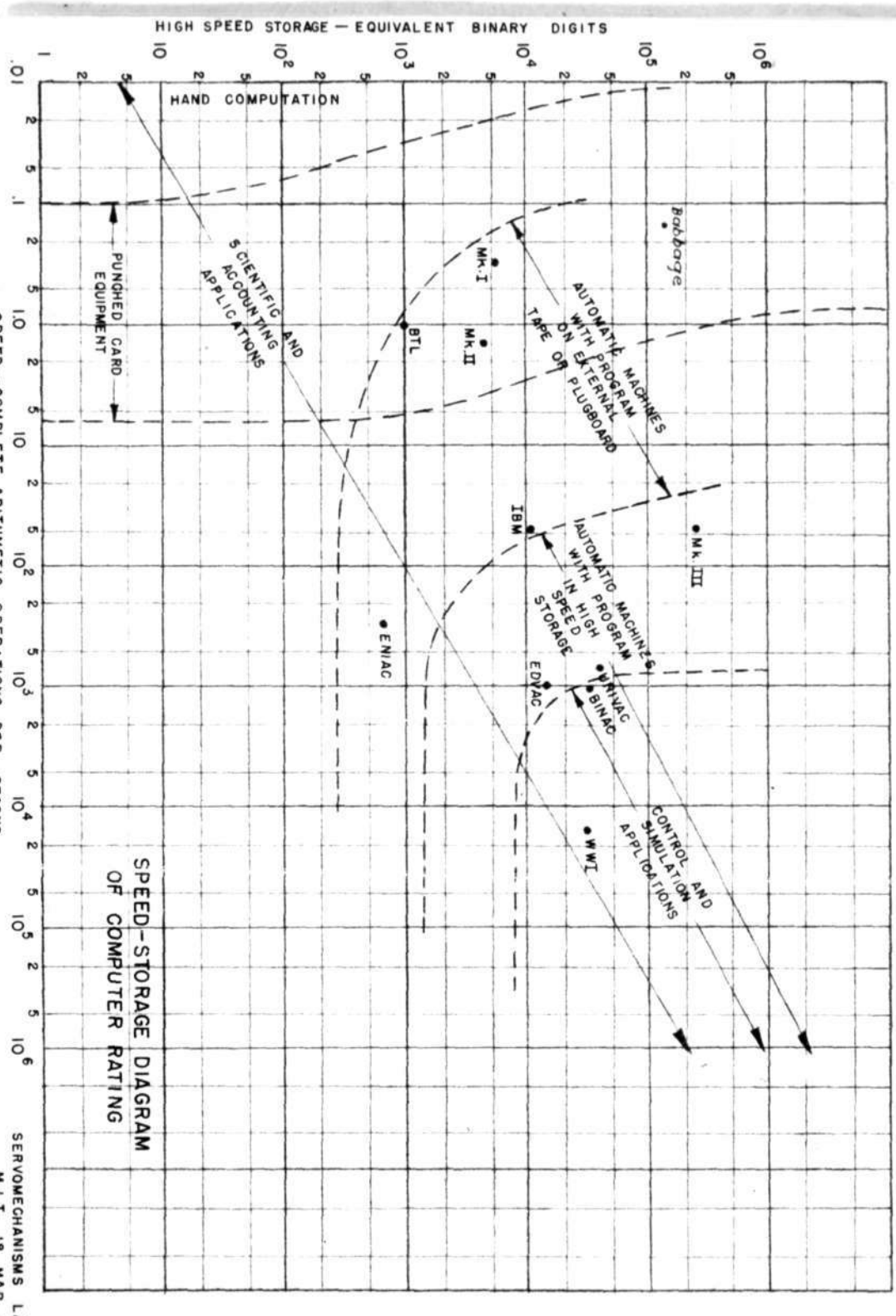

SPEED—STORAGE DIAGRAM OF COMPUTER RATING

SERVOMECHANISMS LAB. M.I.T. 18 MAR. 49

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Memorandum M-823
April 1, 1949

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Cooper, Gerald	006
Corderman, Charles	212
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Dodd, Stephen H., Jr.	256
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